SCIENCE FOR CERAMIC PRODUCTION

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CORRELATION BETWEEN ELASTIC PROPERTIES OF WOLLASTONITE-BASED MATERIALS AND SINTERING TEMPERATURE

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The dependence of the elastic properties of materials based on natural wollastonite on the sintering temperature is considered, which is important in the case of a narrow sintering interval. It is established that the elasticity modulus, with increasing sintering temperature, grows to 7.3×10^4 MPa and the Poisson coefficient varies insignificantly and is equal to 0.22 – 0.28.

In view of stricter requirements imposed on the environment-related purity of heat-insulating ceramics, for instance ceramics used in metallurgy and the automobile industry and asbestos, which is dangerous to health, they must be replaced by environmentally pure materials, in particular, by natural wollastonite [1], which has unique properties: low thermal conductivity, absence of wettability in melts of some nonferrous metals, health safety, etc. Wollastonite can be successfully used in the production of nonferrous materials, for instance, aluminum.

An important aspect in the development and use of new materials is the investigation of their physicomechanical characteristics: strength, elasticity modulus E, sheer modulus G, Poisson coefficient μ, as well as porosity, structure, thermal characteristics, etc.

We have investigated the elasticity modulus and the Poisson coefficient of several samples based on wollastonite, whose compositions are described in [2]. The elastic properties were estimated by measuring the frequency of resonance acoustic vibrations in disc-shaped samples 20 mm in diameter and 2 – 5 mm thick produced by molding at pressure of 10 MPa and subsequent sintering at 800 – 1150°C. The procedure and the instruments used for measuring elastic parameters were the same as those described in [3]. The porosity of samples was determined according to the method described in [4]. The results of the measurements are listed in Table 1 and shown in Figs. 1 and 2.

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The sheer modulus is calculated from the formula

$$G = \frac{E}{2(1+\mu)}.$$

Its values are within the limits of $(0.83 – 2.96) \times 10^4$ MPa.

The results obtained show that the sintering temperature and porosity have a significant effect on the elastic properties of wollastonite materials. The elasticity modulus decreases linearly with increasing porosity and increases with increasing sintering temperature. The latter fact can be accounted for by the presence of polymorphous crystalline silica phases in the material, which are formed in heating quartz contained in initial wollastonite [5].

The Poisson coefficient is weakly related to porosity and temperature. The Poisson coefficient decreases insignificantly with increasing sintering temperature and is equal to 0.28 – 0.22, which is typical of ceramic materials.

TABLE 1

Sample	Sintering temperature, °C	Porosity, %	Elasticity modulus, 10^4 MPa	Poisson coefficient
1	800	46.0	2.20	0.280
2	850	45.0	2.26	0.235
3	900	42.6	2.70	0.220
4	1000	32.4	3.45	0.241
5	1100	1.1	7.20	0.220
6	1150	0.6	7.30	0.235

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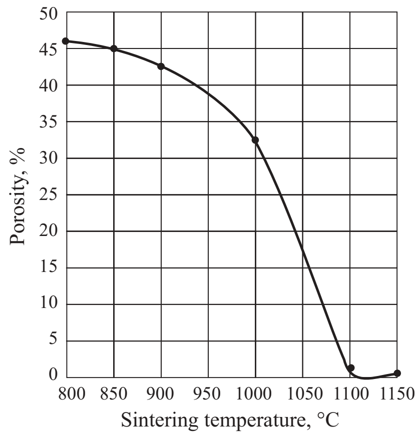

Fig. 1. Dependence of sample porosity on sintering temperature.

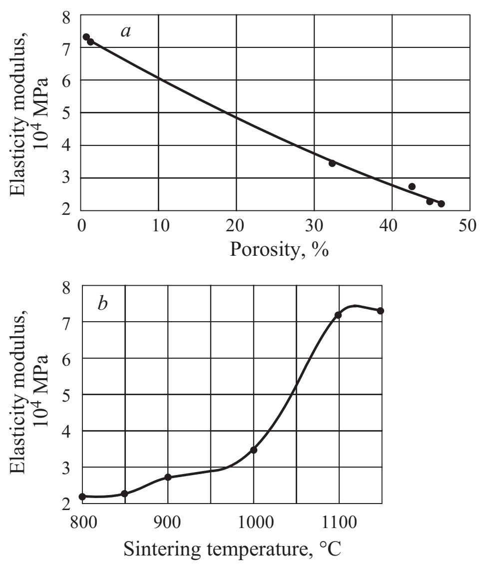

Fig. 2. Dependence of elasticity modulus of samples on porosity (*a*) and sintering temperature (*b*).

The sharp increase interval in the elasticity modulus coincides with the sintering temperature interval of wollastonite material [2].

The elasticity modulus of the material considered is close to that for porcelain, steatite, cordierite, and quartz glass and is somewhat higher than the elasticity modulus of asbestos [6, 7].

Thus the elasticity modulus of wollastonite materials grows as the sintering temperature increases from 800 to 1150°C. The Poisson coefficient decreases perceptibly, i.e., from 0.28 to 0.22, as the temperature grows from 800 to 900°C, and then remains virtually constant and on the average is equal to 0.23.

The study of elastic properties (elasticity modulus and sheer modulus) of the wollastonite material considered corroborated the appropriateness of the temperature interval of sintering selected for wollastonite mixtures of the particular composition, which is important for the case of a narrow sintering interval.

Knowledge of the elastic properties of wollastonite-based materials opens new areas for its application as a matrix phase of composite materials and is needed for the calculation of strength parameters in the development of new materials with prescribed properties.

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